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Valuing Water Quality Improvement in China

A Case Study of Lake Puzhehei in Yunnan Province

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Abstract

While polluted surface water is encountered across most of China, few economic valuation studies have been conducted on water quality changes. Limited information about the economic values associated with those potential water quality improvements or deteriorations is a disadvantage for making proper choices in water pollution control and clean-up activities. This paper reports an economic valuation study conducted in Yunnan, China, which aims to estimate the total value of a real investment project to improve the water quality of Lake Puzhehei by one grade level. Located in Qiubei County, which is far from large cities, the lake has been experiencing fast water quality deterioration in the past years. A conservative estimation strategy shows that on average a household located in Qiubei County is willing to pay about 30 yuan per month continuously for 5 years for water quality improvement, equivalent roughly to 3 percent of household income. The elasticity of willingness-to-pay with respect to income is estimated to be 0.21. The economic rate of return of the proposed project is estimated to be 18 percent, indicating a strong demand and high efficiency of investment in water quality improvement in China. This study also demonstrates that previous knowledge about water quality changes and the project may have a significant positive impact on people's valuation, and that the interviewer effect on valuation can be negative.

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Valuing Water Quality Improvement in China:

A Case Study of Lake Puzhehei in Yunnan Province

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1. Introduction

Polluted surface water is encountered across most of China, as a byproduct of its rapid economic development over the past three decades. However, few valuation studies have been conducted in China to estimate the economic damage of the water quality deterioration or to measure the potential economic value of water quality improvement in the lakes and rivers. Many observers believe that massive and serious surface water clean-up efforts are urgently needed in China. However, the lack of information of the economic values of cleaner waters in the rivers and lakes and the damages imposed to the society by water pollution is a handicap for making informed judgments on clean-up investments.

This paper reports a contingent valuation (CV) study conducted in Yunnan Province of China in 2007 on a lake water quality improvement project that is proposed to be financed by the World Bank. The multiple bounded discrete choice (MBDC) value elicitation method and the stochastic valuation modeling strategy are employed in this study in order to deal with the potential uncertainties involved in the valuation process. As the investment project under valuation is real, the potential hypothetical bias associated with the CV method is expected to be at its minimum. This study also provides analysis on the potential influences of project information provision, project benefit perception, and interviewer's presentation, on the value estimation. The total economic value of the project benefits is compared to the project cost and the economic rate of return of the project is computed. It is expected that the study can contribute to the policy debates on investments in water pollution clean-up in China.

The paper is organized as follows. In the following section, we briefly review the existing literature on CVM application to water quality improvements in China. In section 3 we introduce the Lake Puzhehei water quality improvement project and the potential benefits this project may generate. The survey development, implementation and summary statistics are reported in section 4. In section 5, we present the analytical framework and the estimation results. Conclusions and discussion are provided in section 6.

2. Policy Context and Previous Research

The water resources in China are overall abundant, but scarce in per capita terms and in some regions. China's renewable water resources at per capita basis is estimated at 2,156 m3/year in 2007, only one-fourth of the world average of 85,49 m3/year. In northern part of China, the water availability is even worse, only 757 m3/year per person (World Bank, 2009). At the same time, water demand is increasing due to the continuing economic growth, population increase, industrialization and urbanization.

Accompanying with the water scarcity problem is the water quality deterioration in China's extensive water systems. Caused by pollution from the vast discharges of industrial and domestic wastewaters, the indiscriminate solid waste disposal and the runoff from the agricultural sectors characterized by excessive use of fertilizer and pesticides and large-scale livestock breeding, about 25,000 square km of Chinese lakes fail to meet the water quality standards for aquatic life and about 90% of the sections of lakes around urban areas were seriously polluted (MWR, 2005). Among the 412 sections of the seven major lakes monitored in 2004, 42% meet Grade I-III surface water quality standard which have acceptable water quality, 30% met Grade IV-V which have been significantly polluted, and the rest 28% fail to meet Grade V[1] with worst pollution. Serious water pollution has penetrated beyond infecting the surface water found in lakes, rivers and streams, and over half of the cities now have polluted groundwater (Siciliano 2005). The widening gap between water demands and limited supplies and the deteriorating water quality have made China faced with huge challenges for supplying safe and clean water to its large population as well as maintaining sustainable development.

The empirical estimates of total economic values associated with water quality improvements in China are still very limited. In the area of valuing the benefits of public water quality improvement projects in China, we found 13 studies, with various research quality. As the northern and eastern China in general suffer more from air and water pollution problems, most of the previous studies focused on the lake basins and lakes located in these regions. Most of the studies used the contingent valuation method. Many of the studies reported high percentages of respondents who are willing to contribute a positive amount to the hypothetical water quality improvement projects proposed in the surveys (96.5% in Zhang et al., 2002; 73.6% in Hu et al., 2009; 76.5% in Cai and Zhang, 2006, 2007; 81% in Du, 2003; 74.2% in Zhang et al., 2007 and 78.4% in Zheng and Tu, 2009). This actually reveals the fact that most of the Chinese people are aware of the seriousness of the water pollution problems in China. The reported willingness to pay varies between 0.21 and 8% of annual household income (Swanson et al. 1999; Du, 2003; Xu et al. 2003; Xu et al. 2006 and Zhang et al., 2007).

Concerning the willingness-to-pay (WTP) elicitation methods, almost all of the studies used the simple payment card format which invited respondents to choose one number among the proposed payment list. Only Xu et al. (2006) performed the single- and double-bounded dichotomous choice strategy and Du (2003) used the open-ended question, where the respondents were firstly asked if they are willing to pay a yearly amount for having water quality improved, and then were directly asked of the WTP amount.

[1] More details about the water quality grade can be found in appendix.

Almost all of the papers indicated that income of the respondents (or their households) was positively and significantly correlated with the reported WTP. Some studies, such as Xu et al. (2003), Zhang et al. (2007), Ge et al. (2009), Hu et al. (2009) and Zheng and Tu (2009), also found positive and significant impacts of education level on the reported WTP. Having an urban Hukou (registered residence) seemed to have a statistically significant correlation with high WTP (Zhang et al. 2002; Xu et al. 2003 and Zhang et al. 2007). Several papers confirmed the statistically significant positive roles of strong environmental conscience and confidence in government in forming WTP values (Zhang et al., 2007, Zheng and Tu, 2009; Cai and Zhang, 2006, 2007; Hu et al. 2009). Zhang and Tu (2009) also found that respondents having experienced water pollution crises in the past in general reported higher WTP.

However, almost all of these studies suffered from the potential hypothetical biases and interviewer biases, and the uncertainties involved in the studies have not been well addressed. Only a couple of studies were conducted with good quality and published in peer-reviewed journals. More serious research efforts in water quality valuation in China are warranted.

3. Water Quality Improvement of Lake Puzhehei

Lake Puzhehei is located in Qiubei County of Yunnan Province. Yunnan has in general abundant natural resources, a unique geography and ecological environment, a distinct cultural heritage, and a significant population constituted by ethnic minorities. The accelerating urbanization process and speedy development of tourism during the last several years exceed the carrying capacity of present municipal environmental infrastructure, putting great pressure to the continuous increase of urban general welfare. Only 40.5% of wastewater is treated in Yunnan. Most of the Province's main lakes and rivers suffer from organic pollution, and particularly those flowing through or nearby urban areas, though pollution prevention and treatment has been strengthened. Among the sections of the major lakes, only 52.7% meet or are better than the water quality standards for Grade I-III. 26.7% are polluted and degraded to Grade IV or V, and 20.6% are severely polluted and worse than Grade V. The lakes are largely contaminated by organic pollutants; some suffer particularly from eutrophication. Among the 22 main lakes and water basins, the clean and the comparatively clean lakes (Grade I-III) accounts for only 54.6%; the polluted lakes (Grade IV) and the seriously polluted lakes accounts for over 45.41%. Across Yunnan, wastewater treatment, a crucial component in reducing lake pollution, is practically nonexistent. There are only 38 wastewater treatment facilities in Yunnan, 10 of which are located in municipality Kunming, the capital of the province. 90 counties and municipalities in the province have no wastewater treatment facilities.

Compounding the problem of too few wastewater treatment plants is the lackluster condition of existing facilities. In a spot check of 13 wastewater treatment facilities in Yunnan by the provincial environmental supervisory unit, it was discovered that six of the plants were incapable of "normal operations".

The Lake Puzhehei, meaning “fish and shrimp pool” in the Yi language, is 2.5 km long, 300 meters wide and about 3 meters deep, covering an area of 85 square km. It is located about 175 miles south of Kunming and 7 miles from Qiubei County in Wenshan Prefecture of Yunnan Province. In the area there are 51 isolated peaks with the village houses of red tiles scattered on the sides. Living in the houses are 3,000 Yi people. Mount Dalong, 109 meters above the water level, is located to the southwest of the lake, and eight karst caves link each other at the foot of it. A lotus pool with an area of 300 hectares, stretching 5 km, reflects forests on the hills, presenting scenery of exceptional charm.

However, as other lakes in Yunnan province, water quality in Lake Puzhehei has been deteriorating steadily over the last several years. Most of the water body can only meet with the standard of Grade III and some with Grade IV. Lake Puzhehei is currently at a perilous turning point between medium and heavy eutrophication, which eventually removes oxygen from a body of water and leads to the destruction of all animal life.

In 2007, the Government of Yunnan Province requested the World Bank to support its Yunnan Urban Environmental Program (YUEP), which expects to generate positive externalities by providing critical urban infrastructure and enhancing the watershed environment including Lake Puzhehei. In particular, it is expected to promote local economic development (including tourism), increase property value, the output of livestock and fishing, reduce damage from future flooding and increase the biodiversity of the lake areas. In addition, the program would also improve public health by reducing water-borne and air-borne diseases and enhance the quality of life of program beneficiaries.

The project for Puzhehei is to protect the lake from further, and perhaps irreversible, degradation and to enhance access to basic environmental infrastructure. The project will first purify the wastewaters at the four intake rivers by building artificial wetlands, collect and treat wastewaters and solid wastes from nearby villages, and return some of the farming lands to wetlands. Specifically, the project activities include:

a) Return the farming lands in Xianren village and Shuiweiying village, if within 50 meters to the lake water surface, to wetlands and plant trees and water grasses to purify the water and improve the scenic view of the lake;
b) Improve the environment of 8 villages which are on the lake banks and 56 nearby villages by building dry latrines for 3935 households, 38 public latrines, 99 garbage collection pools, and some village wastewater and solid waste collection and treatment facilities;
c) Plant water grasses in the 4 rivers which flow into the lake and build a facility to collect and treat the wastewater at the Yuezheda river.

This project should have significant impacts on the water quality in the lake and rivers and on the overall ecological conditions and natural environment. Even though it is difficult to precisely predict the impacts on the water quality, the preliminary estimations show that the water quality of the surrounding rivers will be improved by one grade level, i.e. from current Grade IV to III. The water quality in the lake will not deteriorate anymore, and part of the water will be improved from current Grade III to II.

4. The Survey

4.1 Survey Design and Administration

A contingent valuation survey was conducted in July 2007. Prior to the survey, several focus group discussions were organized, where the project team consulted with various local community groups, including those working on the investment project, government officers, and more importantly the local residents. Perceptions and attitudes toward the local economic and environmental situations, the investment project, the improvement of environmental quality, as well as possible payments for the improvement were discussed. A draft questionnaire was then developed and finalized after three rounds of pre-tests.

In order to better present the project and the outcome, a package of visual aids were developed; examples of the visual aids, which include tables, pictures and maps, are presented in **Appendix 2**. The maps show where and how those projects would be implemented. Pictures and words are used to present the water qualities and the changes. A detailed description of different grades of water quality (Grade I to Grade V or worse, also see **Appendix 3**) in a plain language and their impacts on daily lives and activities was also developed to describe the water quality changes. A good feature of these WTP surveys is that the

hypothetical nature of the contingent valuation surveys can be kept to the minimum, as it is real project under preparation.

A multiple-stage stratified random sampling approach was adopted to select sample in Qiubei County. In the first stage, based on the project area and beneficiaries, geographical boundaries (e.g. districts, urban and rural) were determined so that the sample can cover all the geographical areas and spatial representations of the project. Qiubei County was therefore selected in this first stage. After considering the survey cost and the population covered in Qiubei, a total sample size of 500 was determined. In stage two, Qiubei County was further divided into several functioning zones based on their relations to the project implementation and the impacts by the project, and a list of representative functioning zones were chosen to conduct the survey. In stage three, those selected functioning zones were further divided into communities, and a number of communities were randomly selected to conduct the survey. In stage four, a list of households in each community was obtained with the help of local project workers, and the team randomly picked households from the list to ensure the principle of representation in sampling. The sample sizes were determined to be proportional to the population sizes of different categories. **Table 2** illustrates the detailed sampling statistics in Qiubei. We obtained totally 507 relatively well-filled questionnaires. Among them, 245 coming from the urban areas: 100 coming from the Qiubei county town (County government area, Donghu, Zhenxing, Xiazhai, Qiaotoucun / Xiaoxinzhai / Shuizhai), and the rest of sampled respondents from rural area (82 from 8 villages within the lake area, 125 from 56 villages around the lake, 200 from remaining rural districts in the county).

Specifically trained enumerators from Yunnan Environmental Information Center conducted in-person interviews. Care was taken that only the head of a household was interviewed, who should be well aware of overall income and expenditure of the household, and who can decide about additional expenditures. Neutrality as well as anonymity of the survey was ensured at the beginning of each survey. About 50% of the interviews were conducted with a one-on-one, traditional personal interview format, where an enumerator read the questionnaire and recorded down the answers. Another 50% of the interviews were conducted with a group setting, where 4 to 6 respondents sit together in a room and wrote down their answers independently while an enumerator read the questionnaire and provided instructions; the answers of the respondents were not shared with each other and privacy and anonymity were ensured. With a group setting, the potential interviewer effect may be reduced but the completeness of the questionnaire answers may suffer. Each individual interview lasted approximately 20-30 minutes, and each group interview lasted about 40-50 minutes. At the end of each field day, field coordinators checked the returned questionnaires for completeness and accuracy according to a quality checklist.

4.2 Questionnaire Content

The questionnaires finally adopted in the survey included four parts. The first part was about the socio-economic characteristics of the respondents. These questions aimed to obtain information about household heads' personal or household information, such as gender, age, education level, occupation, source of income, disposal income, expenditure, current and future income change, etc. The second part concerned the attitudes and perceptions of the respondents towards environmental quality and the changes. The questions included in this part inquired respondents' perceptions on the priority order for local government expenditures, their knowledge about important environmental issues, their willingness to donate money or labor for environmental protection, their projection of impacts of environmental degradation/improvement on future income, and their media exposure to environmental issues, etc. The third part of the questionnaires gave description on the detailed project activities and their impacts with visual aids. This part inquired the level of knowledge of respondents on the investigated projects, their attentions to the media exposure of the projects and their projection of the impacts of the project on their income and long-term welfare.

The last part of the questionnaires was about WTP. In this part, respondents were told that without financial supports from the household, it is impossible to implement such project. Therefore some fund would have to be collected on a monthly basis, like collecting utility bills, continuously for 5 years. The funds collected would be solely and transparently used for the projects. With certain costs to the households, if the majority supports for the project, it would be implemented; if not, the proposed project would not be implemented. Then respondents were asked to compare his or her household's WTP with a list of prices offered and to tell the likelihood that the household would support for the project with a specific cost to the household.

A multiple bounded discrete choice question format (**Table 1**) was chosen to elicit people's WTP, because this is a more efficient WTP information collection approach although it can be more difficult for respondents to answer (Welsh and Poe, 1998). A list of bid prices and five verbal choice options, "definitely yes", "probably yes", "not sure", "probably not" and "definitely not," are provided, allowing the respondent to express their certainty in agreeing to pay at various offered prices. By numerically encoding these probability answers, it can be used to estimate a valuation distribution for each individual based on the stochastic contingent valuation approach (Wang and Whittington, 2005).

Three follow-up questions were also asked (**Appendix 4**). One question concerned the reasons if one refuses to support the project even at the price of zero. The second was to investigate the reasons for which one is ready to pay 500 yuans per month. The final question of the survey checked respondent's expectation on the level of feasibility to realize the water quality improvement objective established by this project.

4.3 Summary Statistics of Sample Characteristics

Table 4 summarizes the statistics of the sample characteristics. Of a total 485 in the effective sample, 70% of the respondents are males. The average age is 38.7 years, with the youngest respondent age 17 and the oldest age 75. The average household income in 2006 was 12,572 Chinese yuan (or 1546 US dollars), with average household size of 4.5. Forty-six percent of the respondents are farmers, followed by government employees (20%) and professional staff (17%). Seventy-three percent of the respondents attained secondary education or above, and 89% respondents are married. Sixty-one percent of the households indicate that household income is enough to meet household needs, and 34% of households increased their income in 2006 compared with 2005. Thirty-eight percent of the households were uncertain about their household income in the next 5 years. About 79% of the households own the house where they currently live, and about 62% have made a donation in the past.

With regard to perceptions toward environmental problems, access to education, public transportation and underground and lake water contamination are identified as the three most important priorities for local government. Pertaining to the environmental issues, water pollution from municipal and agriculture sources, solid waste management and deforestation are regarded as most problematic. Eighty percent of respondents have visited Lake Puzhehei before, and 56% of respondents are aware of the changes in water quality in Lake Puzhehei through the media. About 30% of respondents have income directly related to Lake Puzhehei such as providing food, accommodation and transportation services. Thirty percent of the respondents perceive Puzhehei protection as the sole responsibility of the local government. About 35% consider deterring further deterioration in Lake Puzhehei as important for tourism development, public health or future generations.

The current usage of Lake Puzhehei revealed that a substantial share of households have utilized the lake water in the previous year. For example, 79% of respondents or their household members visited Lake Puzhehei last year; 61% have noticed the change of water quality in recent years; and 10% used lake water for irrigation in 2006.

As far as Puzhehei water quality project is concerned, only 7% respondents have ever heard the project being proposed before. Thirty-nine percent of the households are currently living within the project domain, making them direct project beneficiaries. When responding why they perceive the project as important, income increase, lake view improvement, swimming condition improvement, environment protection, health benefit, tourism benefit, and next generation benefit are all frequently mentioned by the respondents (19%, 36%, 16%, 36%, 39%, 36%, and 46%, respectively). A majority of respondents (87%) have confidence that the project would prevent lake water from further deterioration. 56% of the interviews are conducted individually and the remaining 44% of interviews are conducted in a group setting.

5. WTP Estimation

5.1 Analytical Framework

We followed the estimation strategy proposed in Wang and He (2010) to conduct the empirical analysis, which is summarized below. Suppose an individual i's WTP is V_i, which is a random variable with a cumulative distribution function F(t). The mean value of V_i is μ_i and the standard variance is σ_i. The WTP model can be written as,

$$V_i=\mu_i+\varepsilon_i \quad (1)$$

where ε_i is a random term with a mean of zero. Individual i knows his valuation distribution. When given a price t_{ij}, the probability for the person to say "yes" to the offer t_{ij} will be,

$$P_{ij} = Prob(Vi>t_{ij})=1-F(t_{ij}) \quad (2)$$

Once P_{ij}, the probabilities for individual i to agree to the price t_{ij}, is known to a researcher, either by assigning numerical values to the verbal MBDC data or by directly asking individuals of their numerical likelihood information as did with the SPC approach, equation (2) can be estimated for each individual.

The estimation model can be constructed as follows:

$$P_{ij} = 1-F(t_{ij}) + \lambda i \quad (3)$$

where λ_i is an error term with a mean of 0 and a standard variance of δ^2. δ can be constant for a respondent i, but different for different respondents. P_{ij} is a dependent variable, which is the uncertainty answer given by a respondent i at price j. P_{ij} takes values between 0 and 1, and can be viewed as a continuous variable. t_{ij} is an independent variable, which corresponds to the bid price proposed in the questionnaire, and t_{ij} is also a continuous variable.

Assume a specific functional form for $F_i(\bullet)$, such as of a normal distribution, with a mean μ_i and a standard variance σ_i , i.e., $F(t_{ij})=\Phi(\frac{t_{ij}-\mu_i}{\sigma_i})$, then the model (3) becomes,

$$P_{ij} = 1 - \Phi(\frac{t_{ij}-\mu_i}{\sigma_i}) + \lambda_i \quad (4)$$

The major purpose of the analysis is to estimate and analyze μ_i, the mean value of V_i for each respondent, which is function of personal information such as personal characteristics and uncertainties, etc.

This paper uses the normal distribution assumption throughout the analysis of WTP estimation and determinants. As a sensitivity check, we also conduct separate estimation under an alternative distribution assumption, which assumes $F_i(\bullet)$ follows a log normal distribution. The results reveal negligible difference in estimated WTP and determinants of WTP between normal distribution and log normal distribution assumptions. Therefore, we merely report the WTP estimation results under log normal distribution assumption, while the determinants of WTP are not presented in the paper[2].

Under the normal distribution assumption of probabilities, we employ the two-stage approach proposed in Wang and He (2010)[3]. The estimation under log normal distribution of the functional form of Fi(•) is similar.

Stage 1: Estimate equation (4) for each individual i. Assume λ_i has a normal distribution. Then,

$$\frac{Pij - 1 + \Phi(\frac{tij-\mu i}{\sigma i})}{\delta} \sim N(0, 1).$$

The log likelihood function then is:

$$\text{Log Li} = \sum_{j=1}^{J} \log \phi(\frac{Pij - 1 + \Phi(\frac{tij-\mu i}{\sigma i})}{\delta}) \quad (5)$$

where $\phi(.)$ is a standard normal distribution probability density function. This is equivalent to a least square nonlinear estimation; δ has no influence on the estimation, as long as it's a normal distribution. With the log likelihood function (5), μ_i can be estimated for each individual i.

[2] The results are available upon request.

[3] In contrast to the estimation model presented in Wang and Whittington (2005), the equation (4) adds an error term to the probability model, which reflects the consideration that probability values given by respondents may have deviations from their valuation distributions.

Stage 2: Analyze determinants of μ_i. Once μ_i is estimated for each individual, models can be constructed and estimated to analyze their determinants. One simple example is to have the following linear functional forms:

$$\mu_i = \beta 0 + xi'\beta + e \quad (6)$$

$$\sigma_i = \nu_0 + z_i'\nu + e_2 \quad (7)$$

where x and z are personal specific variables such as the personal characteristics and uncertainties, etc. $\beta 0$ and β are coefficients to be estimated; e is random errors which reflects uncertainties that a researcher has and can be homogeneous.

As the values assigned to P_{ij} are concerned, we code payment probabilities of 0.001, 0.25, 0.50, 0.75, and 0.999 to the payment probabilities "definitely not", "probably not", "not sure", "probably yes", and "definitely yes", respectively, like Wang and He (2010) did. The mapping of uncertainty categories into probability scales is controversial because it is subject to subjective discretion. For example, Evans et al. (2003) used slightly different coding strategy, which gave 0.0, 0.15, 0.5, 075, and 1.0 to these subjective probabilities. We acknowledge that the WTP estimated will be sensitive to the probabilities attached to payment responses: an assignment of 0.25 to "probably not" answer will definitely generate a higher WTP relative to the assignment of 0.15, but such arrangement should not have significant impacts on the analysis of WTP determinants. Except for selecting arbitrary probability values, an alternative is to randomly generate probability values for each individual whose answer falls in specific uncertainty categories, for example, a random number between 0.00 and 0.50 for "probably not" category. While this avoids the subjective discretion in recoding the data, the estimated mean of WTP should not be affected by this random assignment because any random assignment of the probability number, say between 0.00 and 0.50, will finally make the mean of population converge to the median of the range, which is 0.25 in this case. Once the probabilities of 0, 0.5 and 1 are determined on an individual's valuation distribution, the mean WTP estimation is very stable.

5.2 Summary Statistics of WTP Answers

The statistics of the responses to the MBDC format WTP question are summarized in **Table 3**. For each price listed in the questionnaire, the percentage of respondents who chose a specific likelihood answer is provided. We can see that the percentage of "definitely yes" answers is decreasing rapidly from about 98.0% at the price of zero to 9.5% at the price of 40 yuan. While the percentage of "definitely no" answers increases steadily with the price offered, from 1.0% at price of zero to about 79.1% when the price increases to 50 yuan. Between 5 and 30 yuan, 18 to 25% of the respondents chose the "probably yes/no" or "not sure" response options, showing the respondents actually have relatively important uncertainties in their preference to the bid prices proposed in the WTP question.

5.3 Estimation Results

After removing those individuals who had incomplete individual information or unreasonably high[4] WTP estimates relative to their incomes, 485 households entered into our final analysis with complete individual information and valid WTP responses. In mean WTP estimation, all redundant answers, such as the answers to those prices higher than a price where a person gives a "definitely no" answer and the answers to those prices lower than a price where a person gives a "definitely yes" answer, were deleted. For each person, there were 2 to 23 WTP answers kept for analysis.

In the estimation, an estimate of the mean and standard variance of individual WTP distribution was obtained for each respondent by maximizing the log likelihood function. The distributions of the mean value (μ) and the standard variance (σ) under both WTP normal distribution assumption and log normal distribution assumption were reported in **Table 5.** Under WTP normal distribution assumption, the population mean of individual's WTP mean value was estimated 29.75 yuan, the median is 10.27 yuan, and the population standard deviation of the WTP mean value was 81.22 yuan. The estimated higher value of the mean than median is primarily driven by a few extreme values at the highest end[5]. The respondent-specific variance σi should be regarded as a measure of uncertainty for each individual i. The population mean of individual's WTP standard variance was estimated to be 13.86 yuan, the median value is 1.49 yuan, the population standard deviation of the WTP standard variance was estimated to be 57.53 yuan. Under WTP log normal distribution assumption, we obtained mean WTP at about the same level with those under normal distribution: the population mean is 33.36 yuan with median at 10.81 yuan, and population standard deviation of WTP mean is 88.53 yuan. The median value of WTP standard

[4] Three outliers have the values exceeding 20% of their household incomes.
[5] They are still plausible estimates because the estimation accounts for relatively a small fraction of their household income.

variance is also comparable to that under normal distribution, which is 2.51 yuan. However, the population mean (16357 yuan) and population standard deviation (117542 yuan) of WTP standard variance are much higher due to the extreme values.

Determinant analyses under both WTP normal and log normal distribution assumptions yield similar results. The detailed estimation results of the second stage under normal distribution assumption are presented in **Table 6**[6]. Log linear functions are specified for both the mean value function and the standard variance, and both models are statistically significant, with reasonable R square values.
For the WTP mean value estimation function, we found most social, economic and demographical variables showing reasonable results. Age was negatively correlated with WTP, suggesting that the older population expected to obtain smaller total benefits in their rest of life time from the project relative to younger population. Income (in log terms) was positively significant, the coefficient of which indicating that an increase of 1 percent of annual income will lead to a 0.21 percent increase in monthly WTP mean value. People holding secondary education degree or above generally had significantly higher WTP for lake quality improvement. Past donation is correlated to higher WTP as well. Other determinants did not present significant correlation with WTP, but have high face validity. For example, males and married respondents had a tendency to pay less.

The environmental perception and attitude of the respondent played a generally significant role in the determination of the WTP of a respondent. Respondents who ever heard through media about water quality in Puzhehei had on average 9 yuan of higher WTP, and such difference is significant. The coefficients of the other two variables revealed valid results but t-statistics did not show significant relationship with WTP: respondents who perceived water quality as one of three major problems in Qiubei had tendency to pay 6 yuan more; respondents who believed it is solely the local government's job to prevent Puzhehei water from further deterioration gave smaller WTPs.

Regarding current usage of Lake Puzhehei, we anticipated households using lake water for irrigation were willing to pay less for lake water quality improvement since wastewater contains certain nutrition needed for soil, and the negative and significant sign confirmed our hypothesis. Respondents who already noticed the water quality change during past several years are generally willing to pay 8 yuan more. The other two variables did not show significant association.

[6] The regression results under log normal distribution assumption can be provided upon request.

The project-related variables also presented reasonable results. Those who had already heard in detail about the project for Puzhehei water quality improvement were willing to pay on average 17 yuan more than those having only vague information. Those who believed that the project would increase their household income, improve their lake view and swimming conditions, or protect the ecological system, and who believed the project would have the anticipated effects, were willing to pay more. However, the negative signs of "project will improve health," "project will improve tourism" and "project will benefit next generation" were not what we had expected, but the signs are not statistically significant.

Finally the respondents with individual one-on-one interviews were willing to pay significantly less than those with a group setting, and the difference was roughly 10 yuan. This implies either that the individual interviewer effect is negative or that the group interview effect is positive. As anonymity was ensured in the group setting of interviews, the former implication may be relevant. This implication is inconsistent with the findings obtained in the studies conducted in the developed world, but is consistent with several study results obtained in the developing countries.

We found only few determinants in the standard variance estimation function significant. Age correlated negatively with the variance in respondents' WTP distributions. Income in log terms and education showed positive and significant correlation with WTP variance. The belief that project would improve health generated a smaller standard variance. Individual face-to-face interview survey mode resulted in significantly smaller standard variance. Other variables presented insignificant and generally reasonable associations with standard variance.

The estimation in the second-stage also gave a predicted mean WTP value as well as standard variance value based on simulation. The mean WTP predicted by second-stage is 11.31 yuan, very close to the median of mean WTP estimated from the first-stage. The WTP standard variance is predicted to be 2.29 yuan.

6. Conclusion and Discussion

This paper reports an economic valuation study which aims to estimate the total value of a project to improve the water quality of Lake Puzhehei by one grade level, i.e., from current Grade III to Grade II in the lake and from current Grade IV to Grade III in the surrounding rivers. The lake is located in a rural area of Qiubei county, which is far from big cities, but the water quality has been deteriorating fast in the past 10 years. The potential hypothetical bias associated with this contingent valuation study is expected

to be minimal due to the fact that the project under valuation is a real investment plan, and the local residents treat the project very seriously. The multiple bounded discrete choice (MBDC) value elicitation format and the stochastic valuation estimation approach are used to overcome the potential uncertainties involved in the study.

The results show that on average a household is willing to pay (WTP) about 30 yuan per month continuously for 5 years for implementing the project, with a median value of 11 yuan per month. This WTP is equivalent to roughly 2.9 percent of household income. This result is within the range of the results obtained in previous similar studies conducted in China that is between 1 and 4 percent of income. The total cost of the project is estimated to be 34.02 million yuan, providing a high economic internal rate of return of 18%.

The results generally give reasonable coefficients for WTP determinants. Households with higher incomes would be willing to pay more; the estimated elasticity of WTP with respect to income is 0.21. Older people are willing to pay less; people with higher education are willing to pay more. People who donated to public charities before are willing to pay more. Farmers who use the lake for irrigation are willing to pay less, as the improvement in water quality implies less nutrition in the water. People who believe the project will improve the ecosystem also value the project more.

This study demonstrates that people's previous knowledge about the valuation subject plays a significant role in forming their values of the subject. People who noticed the water quality change before, heard about the project before, or observed press discussions before about the water quality change and the related issues, value the water quality improvement more than those who did not. This may impose a challenge on using WTPs to measure the economic values. The values measured are the perceived ones, and the actual values may be higher, because better are people informed of the subject, more they will be willing to pay. This implies that such WTP studies can significantly underestimate the true values if the issues under valuation are not well presented. A researcher should try best to provide sufficient information to respondents about the subject in survey design and implementation, and should try to calibrate the final estimation after the survey is conducted.

This study also reveals that the interviewer effect can be negative, as the one-on-one individual interviews, where the respondents are aware of the fact that the enumerators know the reported answers of the respondents, provides a lower WTP estimation than those interviews conducted in a setting that the answers are provided anonymously. While the interviewer effect is found generally to be positive in the

studies conducted in the developed countries, negative effects are found in developing countries, where people are generally poor and may not be willing psychologically to reveal that they have money to pay for environmental protection. But no systematic studies have been conducted on this topic, and more research on this is warranted.

Even though this study provides an estimate of a high economic internal rate of return for the Puzhehei investment project, the estimation is based on a conservative valuation strategy. In this estimation, the impacts of previous knowledge of the respondents about the project and the water quality change on valuation are not calibrated, which reduced the total value estimation. The MBDC bid design starting from 0, a lower bound of WTP, may also generate a lower estimation of the total WTP. Furthermore, as this is a real project proposal, the potential strategic bias may also induce a lower estimate of WTP, even though a countervailing concern of losing the project opportunity has been presented in the WTP scenario design. Therefore, the economic internal rate of return of the project may be significantly higher than 18%.

Table 1. Contingent Valuation MBDC Bid Design

Fees per month for five years	Definitely Yes	Probably Yes	Not Sure	Probably No	Definitely No
Free (0 yuan)					
3 yuans					
5 yuans					
10 yuans					
15 yuans					
20 yuans					
25 yuans					
30 yuans					
40 yuans					
50 yuans					
60 yuans					
70 yuans					
80 yuans					
90 yuans					
100 yuans					
150 yuans					
200 yuans					
250 yuans					
300 yuans					
350 yuans					
400 yuans					
450 yuans					
500 yuans					

Table 2. Stratified Random Sampling in Qiubei

Function Areas	Total Population /Households	Total # of Interviews	Selected Sub-districts	Total # of HH	# of Interviews
8 villages within the lake area	16389 /3225	82	Puzhehei village	895	26
			Shuiweiying	547	25
			Caihuaqing	35	5
			Shuanglongyingjie	765	26
56 villages around the lake	32313 /7136	125	Hebian village	439	40
			Baishapo	80	12
			Xiaohebian	11	5
			Dashiqiao	34	5
			Shanlin	151	10
			Dapo	57	10
			Damaichong	121	12
			Baozipo	227	31
Qiubei county town	39620 /6837	100	County gov't area	2820	40
			Donghu	424	10
			Zhenxing	1076	20
			Xiazhai	1483	20
			Qiaotoucun/Xiaoxinzhai/Shuizhai	240	10
Remaining 4 rural districts in the county	80000 /20000	200	Nijiao TS		50
			Shupi TS		50
			Pingzhai TS		50
			Guanzhai TS		50
Total		507			507

Table 3. Statistics of Responses to the Likelihood Questions

(Monthly payment for 5 years, % of responses)

Price	Definitely yes	Probably yes	Not sure	Probably not	Definitely not
0	98.0	0.6	0.4	0.0	1.0
3	76.5	8.3	3.2	0.6	11.4
5	53.6	12.4	8.1	3.0	22.9
10	33.9	11.8	9.1	6.3	38.9
15	21.5	11.0	8.7	5.9	52.9
20	18.5	7.1	6.9	7.1	60.4
25	14.6	7.1	7.5	5.9	64.9
30	13.2	5.5	5.9	6.1	69.2
40	9.5	4.9	5.3	4.3	75.9
50	7.5	4.5	4.1	4.7	79.1
60	5.5	3.9	4.7	4.3	81.5
70	5.3	2.4	5.1	4.7	82.4
80	4.9	1.8	4.3	5.3	83.6
90	4.5	1.4	3.9	5.7	84.4
100	4.1	1.2	1.4	3.9	89.3
150	3.4	0.8	0.4	1.8	93.7
200	3.4	0.6	0.4	1.4	94.3
250	3.0	1.0	0.4	0.8	94.9
300	2.6	1.2	0.0	0.8	95.5
350	2.0	1.6	0.2	0.6	95.7
400	2.0	1.2	0.6	0.4	95.9
450	2.0	1.0	0.4	0.6	96.1
500	2.0	0.6	0.4	0.4	96.6

Table 4. Descriptive Statistics of Variables Used in WTP Function

(Number of observations: 485)

Variable	Description	Mean	Std. Dev.	Min	Max
Social, economic and demographical information					
Male	Male=1, female=0	.70	.45	0	1
Age	Age (years)	38.76	11.50	17	75
Income	Household income last year (yuan)	12,572	12,291	250	70,000
Secondary Education	Have secondary education or above=1, other=0	.73	.44	0	1
Married	Marital situation : married=1, unmarried=0	.89	.30	0	1
Donation	In 2006, did you make any donation for pubic goods? Yes=1. No or do not know=0	.60	.48	0	1
Perception about Environment					
Water important	Respondent list water quality as one of the three most urgent problems of Qiubei County that need to be coped with by the government. Yes=1, no=0	.45	.49	0	1
Press discussion	In 2006, did you hear through media about the water quality in Puzhehei? Yes=1, not or don't know=0	.56	.49	0	1
Government job	Do you think it is solely the local government's responsibility to address environmental issues? Yes =1, not sure or no = 0	.30	.45	0	1
Current use of Puzhehei lake					
Visit lake	Did you or your household member visit Puzhehei in 2006? Yes=1, no or do not know=0	.79	.40	0	1
Notice change	Are you aware that the water quality in Lake Puzhehei has degraded dramatically in the past? Yes=1, no or not sure=0	.61	.48	0	1
Generate income	Did you generate any income from the lake such as providing meals, lodging, transportation and performance services to tourists, etc. in 2006? Yes=1, no or not sure=0	.059	.23	0	1
Irrigation	Did your household use lake water irrigating	.10	.30	0	1

	farmland in 2006? Yes=1, no or do not know=0				
Variables related to project					
Heard project	Have you heard about the water quality improvement project? know details =1, no or heard but no details =0	.069	.25	0	1
Living in project domain	Is your household living within the project domain? Yes, in one of the project areas = 1, no direct relationship = 0	.39	.48	0	1
Project increase income	Do you think your family income would increase with water quality improvement? Yes=1, no or don't know=0	.19	.39	0	1
Project improve view	Project would improve lake view. Yes=1, no or not applicable=0	.36	.48	0	1
Project improve swimming condition	Project would improve swimming condition in the lake. Yes=1, no or not applicable=0	.16	.37	0	1
Project protect ecological system	Project would protect ecological system. Yes=1, no or not applicable=0	.36	.48	0	1
Project improve health	Project would improve health. Yes=1, no or not applicable=0	.39	.48	0	1
Project improve tourism	Project would improve tourism value. Yes=1, no or not applicable=0	.36	.48	0	1
Project benefits next generation	Project benefit next generation. Yes=1, no or not applicable=0	.46	.49	0	1
Project will have effect	Project would prevent lake water from further deterioration? Definitely yes or probably yes=1, not sure, probably not or definitely not=0	.87	.32	0	1
Methodology variable					
Individual interview	Interview mode: individual=1, group=0	.56	.49	0	1

Table 5. Distribution of the Estimated Individual WTP

1. WTP mean

Variable	Percentile	Centile	[95% Conf.	Interval]
Distribution of μ under normal distribution assumption				
	0	.53	.53	.53
	10	1.49	1.49	3.12
The population	20	4.40	4.00	4.40
mean of μ is 29.75	30	5.55	4.89	6.07
	40	8.25	7.64	8.99
The population	**50**	**10.27**	**9.26**	**12.5**
std of μ is 81.22	60	13.62	12.83	15.78
	70	19.06	15.90	23.45
	80	30.70	25.56	37.01
	90	62.84	47.57	71.73
	100	840.50	840.50	840.50
Distribution of μ under log normal distribution assumption				
	0	.000039	.000039	.000039
	10	.13	.13	3.04
The population	20	4.23	4.15	4.23
mean of μ is	30	5.77	5.06	6.81
33.36	40	8.74	8.54	9.02
	50	**10.81**	**9.35**	**13.20**
The population	60	15.06	13.20	16.89
std of μ is	70	21.20	17.63	25.85
88.52	80	32.21	27.91	46.49
	90	75.82	62.62	91.17
	100	1021.78	1021.78	1021.78

2. WTP variance

Variable	Percentile	Centile	[95% Conf.	Interval]
Distribution of σ under normal distribution assumption				

	0	.091	.091	.091
	10	.44	.19	.44
The population	20	.49	.49	.50
mean of σ is 13.86	30	.56	.53	.56
	40	.65	.64	.82
The population	**50**	**1.49**	**1.28**	**2.14**
std of σ is 57.53	60	4.11	2.53	4.67
	70	6.30	5.55	8.82
	80	12.30	9.72	15.23
	90	26.55	18.99	38.03
	100	910.16	910.16	910.16
Distribution of σ under log normal distribution assumption				
Distribution of σ	0	3.11e-09	3.11e-09	3.11e-09
	10	.077	.051	.077
The population	20	.14	.077	.14
mean of σ is	30	.26	.17	.29
16357.3	40	.72	.35	1.37
	50	**2.51**	**1.56**	**8.98**
The population	60	22.65	13.08	36.70
std of σ is	70	61.56	44.23	100.57
117542.5	80	263.76	152.54	473.11
	90	2044.31	891.30	6439.32
	100	1394095	1394095	1394095

Table 6. WTP Determinants with the Two-Stage Approach

Variables	Log WTP Mean (μ)		Log WTP Variance (σ)	
	Coefficient	**t-value**	**Coefficient**	**t-value**
Social, Economic and Demographical Characteristics				
Male	-.032	-0.29	-.16	-1.00
Age	-.011	-2.06**	-.019	-2.84***
Lg(Income)	.21	3.91***	.21	2.66***
Secondary Education	.26	2.21**	.37	2.19**
Married	-.031	-0.17	-.12	-0.46
Donation	.20	1.93*	.21	1.41
Perception about Environment				
Water important	.064	0.61	.091	0.60
Press discussion	.20	1.87*	.18	1.10
Government job	-.15	-1.36	-.11	-0.73
Current use of Puzhehei lake				
Visit lake	.0021	0.02	-.10	-0.52
Notice change	.20	1.79*	.23	1.47
Generate income	.28	1.10	.12	0.32
Irrigation	-.37	-2.18**	-.23	-0.96
Variables related to project				
Heard project	.45	1.86*	.57	1.41
Living in project domain	.14	1.19	-.095	-0.54
Project increase income	.13	0.93	-.0034	-0.02
Project improve view	.069	0.61	.15	0.90
Project improve swimming condition	.10	0.74	-.045	-0.22
Project protect ecological system	.23	2.07**	.14	0.86
Project improve health	-.12	-1.16	-.30	-1.82*
Project improve	-.065	-0.57	.044	0.26

tourism				
Project benefits next generation	-.075	-0.65	-.15	-0.90
Project will have effect	.0015	0.01	.014	0.07
Methodology variables				
Individual interview	-.43	-3.75***	-.79	-4.41***
Constant	.47	0.89	-.19	-0.25
Adjusted R-squared	0.30		0.26	
F value	9.50		10.21	
Observations	485		485	
Mean	11.31		2.29	
(Std. Dev.)	(.55)		(.16)	

Note:

1. *** denotes 1% significance level. ** refers 5% level and * indicates 10% level.

2. The numbers in the bracket below the mean value of WTP is the standard deviation obtained by random draw based on the variance-covariance matrix of estimation results.

3. Estimation obtained under WTP Normal Distribution Assumption

References

Cai, Z. and W. Zhang (2006). Contingent valuation of Yangtze lake's water quality improvement structured by payment card questionnaires. *Journal of Nanjing Forestry University (Natural Science Ediction)*, 30(6): 27-31. (In Chinese)

Cai, Z. and W. Zhang (2007). On the willingness to pay for water quality improvement of Yangtze Lake and payment mechanism in Nanjing area. *Ecological Environment*. 2007(2): 116-119. (in Chinese)

Du, Y. (2003). The Value of Improved Water Quality for Recreation in East Lake, Wuhan, China: An Application of Contingent Valuation and Travel Cost Methods. *Research Report, EEPSEA*, 2003.

Evans, M. F., N. E. Flores and K. J. Boyle, 2003, "Multiple-bounded uncertainty choice data as probabilistic intentions," *Land Economics*, 79(4): 549-560.

Ge, Y., L. Liang, F. Wu and B. Wang (2009). Studies on Willingness to Pay and Payment Level for Ecological Compensation of the Yellow Lake Based on CVM. *IEEE*.

Hu, H., L. Jia and G. Hu (2009). Ecosystem service value estimation of Chizhou Urban drinking water source area based on contigent valuation method. *Journal Anhui Agriculture Science*. 37(16): 7571-7573. (in Chinese)

Ministry of Water Resources (MWR). 2005. *Annual Report*. Beijing: MWR.

Siciliano, M. 2005. "First Development, Then Environment: Environmental and Water Scarcity Issues in China." *The Heinz School Review*. (Policy and Management Paper) Available at: http://journal.heinz.cmu.edu/Current/ChinaEnvironment/ce.html

Swamson. T., B. Day and S. Mourato (1999). Valuing water quality in China: purpose, approach and policy. *Journal of Environmental Sciences*. 11(3): 309-315.

Wang, H. and J. He, 2010. "Estimating Individual Valuation Distributions with Multiple Bounded Discrete Choice Data", *Applied Economics*, 2010.

Wang, H. and D. Whittington, 2005, "Measuring individuals' valuation distributions using a stochastic payment card approach", *Ecological Economics*. 55 (2005) 143-154.

Wang, H, K. Fang, and Y. Shi, 2010. "Economic Valuation of Development Projects: A Case Study of a Non-Motorized Transport Project in India", *World Bank Policy Research Working Paper No. 5422*, available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1678351

Welsh, M.P. and G.L. Poe, 1998, "Elicitation Effects in Contingent Valuation: Comparison to a Multiple Bounded Discrete Choice Approach", *Journal of Environmental Economics and Management*. 36, 170-185.

World Bank, 2009. "Addressing China's Water Scarcity. Recommendations for Selected Water Resource Management Issues", *World Bank Report*, 2009.

Xu. Z., , X., G. Cheng, Z. Zhang, Z. Su and J. Loomis (2003). Applying contingent valuation in China to measure the total economic value of restoring ecosystem services in Ejina region. *Ecological Economics*, 44(2003): 345-358.

Xu, Z., J. Loomis, Z. Zhang and K. Hamamura (2006). Evaluating the performance of different willingness to pay question formats for valuing environmental restoration in rural China, *Environment and Development Economics*, 11: 585–601.

Zhang, Z., Z. Xu, G. Cheng and Z. Xu (2002). Contingent valuation of the economic benefit of restoring ecosystem services of Zhangye Prefecture of Heihe Lake Basin. *Acta Ecologica Sinica*. 22(6): 885-893. (In Chinese)

Zhang, Y. W-H Meng and L. Zhang (2007). Analysis of Effects on Residents' Demand for Urban Public Eco-System Services Based on a Case Study. *IEEE*. http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=4341011&userType=inst

Zheng, H-X. and Q. Tu (2009). Analysis of Willingness to Pay for Environmental Services and Its Impacts in Jinhua Lake. *International Conference on Management Science & Engineering* (16th) September 14-16, 2009. Moscow, Russia.

Appendix 1

Excerpts from the Questionnaire

Background

As you may know, the water quality of Lake Puzhehei has been continuously deteriorating. Since 1997, part of the water has degraded significantly from water quality Grade II to Grade III, and in the surrounding rivers to Grade IV, where the water cannot be used for swimming and it is harmful to have a direct contact for human beings. (Show graphs and pictures in Appendix 2 to explain the water quality changes and the meanings of the water quality grades, and answer any questions.)

Project description

Given the potential negative impacts on tourism and economic development in Qiubei caused by water quality deterioration in Lake Puzhehei, the government of Qiubei County is planning to launch an investment project to protect the lake from further deterioration and even improve the water quality. The project will first purify the wastewaters at the four intake rivers by building artificial wetlands, collect and treat wastewaters and solid wastes from nearby villages, and return some of the farming lands to wetlands. The major content of the project includes:

d) Return the farming lands, in Xianren village and Shuiweiying village if within 50 meters to the lake water surface, to wetlands and plant trees and water grasses to purify the water and improve the scenic view of the lake;
e) Improve the environment of 8 villages which are on the lake banks and 56 nearby villages by building dry latrines for 3935 households, 38 public latrines, 99 garbage collection pools, and some village wastewater and solid waste collection and treatment facilities;
f) Plant water grasses in the 4 rivers which flow into the lake and build a facility to collect and treat the wastewater at the Yuezheda river.

(Present and explain the project activity map and pictures).

Consequences

This project will have significant impacts on the water quality in the lake and rivers and on the overall ecological conditions and natural environment. It is difficult however to precisely predict the impacts on the water quality due to many factors involved. But the preliminary estimation shows that the water quality of the rivers will be improved by one grade level, i.e. from Grade III to II and from Grade IV to III. The water quality in the lake will not deteriorate and will be improved from current Grade III to II.

Cost of the project

Of course there are costs to implement the project. The governments of Qiubei County and Wenshan Prefecture are trying to find different sources to finance the project. However, it is found infeasible to implement the project if there is no financial support from the households in Qiubei County like yours. Qiubei County is considering to collect a monthly fee, like the telephone bill and water bill, continuously for five years, from households like yours, in order to implement the project. The fee collected will be managed by a relevant department and be exclusively used for the project implementation, and the use of the fund will be publicly disclosed.

Willingness-to- pay questions

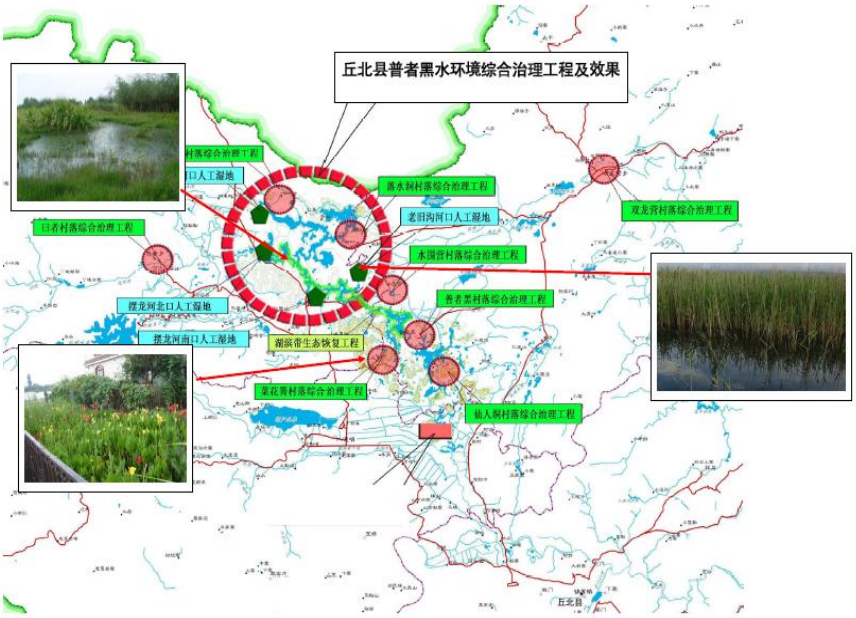
Suppose that the residents in Qiubei County like you have an opportunity to vote on whether or not to implement the project and therefore to improve the water quality of Lake Pushehei. If the majority of people support for the project, the plan would go into effect and every household would have to pay a certain amount. If the majority of people vote against the project, the project will not be implemented, no one would have to pay, and the water quality of the lake would continue deteriorating.

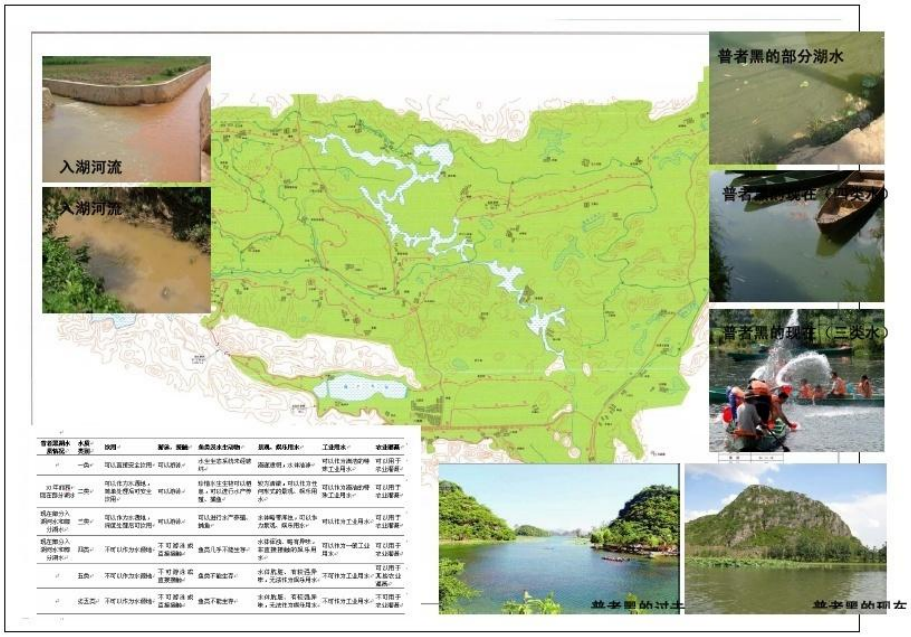
I want to know the possibility for you to support for this project given a certain cost to your household. Considering your current income, as well as your expenses for housing, food, utilities, clothing, entertainment, etc., please think about how much, to the maximum, you would be willing to pay monthly to support for this proposed project for five years.

Please compare your willingness to pay with the fees listed below. For each value of the fees in the table, please choose one probability for you to support for the project. Please note that there are no right or wrong answers and we only want to know your true feelings. (Show MBDC Card in Table 1)

Appendix 2

Survey Visual Aids – Project Activities and Water Quality Pictures and Explanation





Appendix 3

Environmental quality standards for surface water in China

The standard was formulated for the purpose of implementing the Environmental Protection Law of the People's Republic of China and the Law of the People's Republic of China on Prevention and Control of Water Pollution, preventing water pollution, protecting surface water quality and human health as well as maintaining sound eco system. According to different environmental functions of surface water and targets for its protection, the standards provide indexes that need to be controlled and the limits for water environment quality, analytical methods for water quality assessment, enforcement and supervision of the standards. The standards apply to all useable surface waters within the territory of P.R. China including lakes, rivers, canals, channels and water reservoirs. Waters with specific functions shall apply special water quality standards accordingly.

Classification	Grade I	Grade II	Grade III	Grade IV	Grade V
Description	Mainly applicable to water sources and national nature reserve areas	Suitable for grade I drinking water supplies, endangered fish reserves, and fish and shrimp breeding areas	Suitable for grade II drinking water supplies, general fish reserves, and swimming areas	Mainly suitable for general industrial purposes and recreational uses that do not involve direct human contact with the water	Mainly suitable for agricultural uses and general scenic purposes
BOD5	<3	3	4	6	10
DO	90% (or 7.5)	6	5	3	2
Acidity (pH)	6-9	6-9	6-9	6-9	6-9
Total Phosphorus	0.02(L/R 0.01)	0.1(L/R 0.025)	0.2 (L/R 0.05)	0.3 (L/R 0.1)	0.4 (L/R 0.2)
Total Nitrogen	0.2	0.5	1.0	1.5	2.0
NH3-N	0.15	0.5	1.0	1.5	2.0
Fecal coliform	200	2000	10000	20000	40000

Appendix 4

Follow-up Questions on Extreme Answers

(Please answer this question if you chose “not sure”, “probably not” or “definitely not” at fee 0; otherwise please skip this question) Could you please tell us why you are not willing to support the project even when it does not cost your household anything?

Reason	Frequency	Percentage
1. It is not important to improve the water quality of the lake	0	0.0%
2. This project will have a cost to my household even though this household is not directly asked to pay for it	1	33.3%
3. I don’t trust there would be a transparent management of the project fund	1	33.3%
4. Other possible reasons, please specify	1	33.3%
Total	3	100%

(Please answer this question if you chose “not sure”, “probably yes” or “definitely yes” at fee 500; otherwise please skip this question) Could you please tell us why you are willing to support the project even when you are asked to pay 500 yuan per month for it?

Reason	Frequency	Percentage
1. This amount of money is affordable	4	26.67%
2. It is extremely important for household to improve water quality	4	26.67%
3. I want to make contribution to Qiubei County	7	46.67%
4. I am just saying that	0	0%
5. Other possible reasons, please specify	0	0%
Total	15	100%